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the MARINE INITIATIVE

Leasing and Restoration of Submerged Lands

Strategies for Community-Based, Watershed-Scale Conservation

AUGUST 2002

The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. The Conservancy works in all 50 states and in 28 other countries around the world.

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Executive Summary

Emerging threats to the marine environment challenge us to find innovative ways to protect its rich resources. Presently only a handful of strategies for marine conservation have been used successfully; a broader toolkit is needed. One of the most successful strategies for terrestrial conservation has been the acquisition and management of natural resources through ownership, easements and leases of land. Traditionally, management agencies and conservation organizations have assumed that strategies for estuarine and marine conservation must be substantially different than those for terrestrial conservation, in part because it is not possible to "buy the bottom" of the publicly owned oceans (i.e., to apply strategies related to short- and long-term ownership of submerged lands). This may be an unfortunate misconception because in many places around the United States submerged lands are available for lease and ownership; in fact, such leases have often been used by business interests such as oil and aquaculture.

Many coastal and marine ecosystems have been badly degraded because they lie in areas that have been heavily colonized and exploited by humans for centuries. Often the sources of problems that plague estuarine ecosystems lie upstream in watersheds that are being developed incompatibly and polluted from excess nutrients and chemicals. To be effective in the conservation of estuaries and their habitats, we must recognize and understand that ecological processes link estuaries and their watersheds.

In this report we explore the leasing of submerged lands as a potential conservation strategy and examine some of the benefits, considerations and methods of involvement for leasing, preservation and restoration of shellfish on these lands. A nationwide analysis of all coastal states' leasing legislation was done to acquire information regarding submerged land availability, procedures and costs for acquiring a lease, and criteria for maintaining a lease in each state. A variety of leasing options are explored, but we focus principally on the leasing of shellfish grounds because: (i) most state leasing programs have specific provisions for shellfish development and harvest. (ii) Shellfish habitats are among the few types of submerged lands readily available for lease that are amenable to restoration, conservation and management of native species in natural environments. (iii) The restoration and conservation of shellfish encourages stakeholders and local communities to take a strong interest in water quality and the link between estuaries and their watersheds.

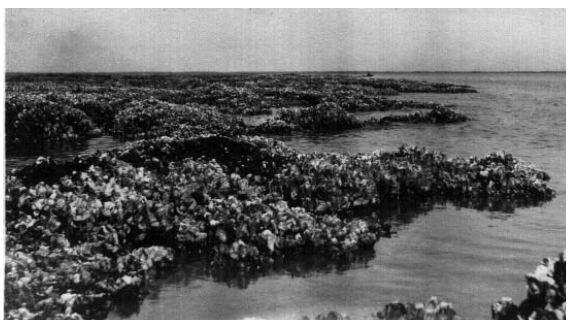
The leasing of submerged lands and shellfish restoration can be combined in four main ways that offer different benefits as conservation strategies: (1) Submerged lands can be leased and then simply protected from extractive activities. (2) Submerged lands can be leased and restored with ecologically functional shellfish communities, then protected. (3) Submerged lands can be leased, restored with shellfish, then sustainably harvested. (4) Submerged lands can be leased, restored with shellfish, then unsustainably harvested. Obviously if conservation is a goal, then unsustainable harvest (option 4) should be avoided. Even though outright protection (options 1 and 2) may be preferred, many conservation benefits can come out of limited and sustainable harvest (option 3). The benefits and considerations of all these options are explored in depth.

The development of strategies that combine the potential of leasing and shellfish restoration provide powerful new tools for coastal and marine conservation. These strategies help local stakeholders secure long-term protection for important habitats, restore ecological processes in coastal watersheds, improve fisheries resources and enhance the quality of life and economic benefits for local communities. Where appropriate opportunities exist this approach may be expanded to enhance coastal marine conservation throughout the United States and even internationally.

< I >

INTRODUCTION

The coastal waters of the United States—from the kelp beds of the Bering Sea to the marshes of Louisiana to the reefs of Florida and Hawaii—contain a significant and under-recognized element of this nation's biological diversity. This immense biological wealth has been slow to receive just recognition, and its economic value remains poorly appreciated. Yet, productive coastal habitats are 10 times more valuable than their terrestrial equivalents in food production, recreation, waste processing and nutrient cycling (Costanza et al. 1997).



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Historical oyster beds such as these near Brunswick, Georgia (1925) positively impacted water quality and provided habitat for many plants and animals. Today there are few if any such expansive oyster reefs left.

As burgeoning coastal populations increase pressure on the limited resources of the coastal seas, threats to the marine environment grow rapidly. Estuaries have been the sites for initial colonization and resource use by humans for centuries and therefore have become some of the most degraded habitats on earth (Edgar et al. 2000). Many estuarine problems have their origins in watersheds, since inappropriate decisions in land and river management eventually accumulate downstream. For example, intensive development and incompatible uses of land and water within watersheds degrade water quality, increase eutrophication and have led directly to the loss of important downstream habitats such as seagrasses, marshes and oyster reefs. Furthermore, changes in freshwater inflow through dams, diversions and other mechanisms alter salinity and sediment regimes within estuaries and disrupt migratory pathways of anadromous species. Incidences of red, brown and toxic tides are increasingly common, and along with pollution and nutrification, make it hazardous to fish, collect shellfish or even swim in many coastal waters. These and other emerging threats to coastal waters challenge us to find innovative ways to protect their rich diversity and resources.

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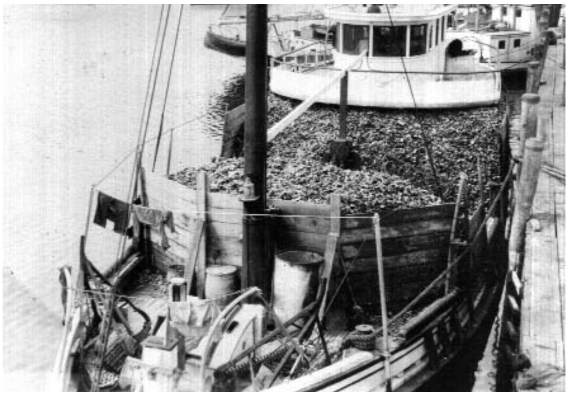
To be effective in the conservation of estuaries and their habitats, we must recognize and understand that ecological processes link estuaries and their watersheds. Bivalve shellfish (e.g., oysters, mussels, clams, scallops; hereafter referred to as shellfish) are good indicators of this link since they filter estuarine water and thus bioaccumulate many of the problems that flow into estuaries from upstream. When their populations are healthy, shellfish can help improve water clarity and quality through their filtering capacity.

Shellfish are some of the most important and historically abundant species in coastal waters. Fisheries for these shellfish have been of historically significant value in many coastal states. Yet now, because of water quality issues, many of these fisheries are in poor shape. The latest surveys by the National Oceanic and Atmospheric Administration indicate that more than 30% of known United States shellfish waters were partially or completely restricted from harvest in 1995, and most (>70%) of these limitations were caused by poor water quality. Furthermore, in some regions, such as the Gulf of Mexico, more than 45% of shellfish waters were harvest limited (NOAA 1997) (Table 1). Where they can be harvested, shellfish are often harvested unsustainably. In the Chesapeake Bay, oysters have been harvested with such abandon that they may never return in the abundance necessary to play the key ecological func-



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Oyster boat, South Carolina (1933). In the past century vast quantities of shellfish have been removed from estuarine systems.

tion of clarifying the Bay's now muddy waters (Jackson et al. 2001a,b). Historically (in the 1800's) the abundance of oysters in Chesapeake Bay was sufficient to filter the entire water column of the Bay in three to six days, but by the 1980's the biomass of oysters had declined to the point that nearly a year would be required to filter an equal volume (Newell 1988).

The conservation of estuarine and marine systems lags far behind the conservation of terrestrial systems. Currently most marine conservation and management focuses on overfishing as the primary threat to marine ecosystems, and marine protected areas (MPAs) as the primary strategy for threat abatement. MPAs are an important tool for marine management and conservation, and significant advances have been made in our understanding of their effects (Roberts and Hawkins 2000, Halpern 2002) as they become established throughout the world. Nonetheless, in the United States and many other countries, progress in identifying and establishing MPAs has been slow. In the past decade only a small set of areas has been designated as MPAs that might have any lasting impact on the preservation of biodiversity[1] despite significant effort by conservation groups and management agencies. The development of MPAs also often has the effect of vilifying fishermen rather than helping them work together with conservationists, managers and scientists.

One of the most successful strategies for terrestrial conservation has been the acquisition and management of natural resources through ownership, easements and leases of land. This strategy has been used successfully in the terrestrial environment by countless groups from agencies to international conservation organizations to local land trusts. It has been commonly assumed that strategies for estuarine and marine conservation must be substantially different than those for terrestrial conservation, in part because it is not possible to "buy the bottom" of the publicly owned oceans (i.e., to apply strategies related to short- and long-term ownership of submerged lands). This may be an unfortunate misconception, because in many places around the United States submerged lands are readily available for lease. Billions of dollars are spent every year in virtually every coastal state to lease and develop submerged lands for oil, marinas, fisheries and aquaculture. For example, most of the southeastern coast of Louisiana is gridded and leased for oyster harvest[2]. Leasing submerged land for aquaculture is a big and growing business. The National Marine Fisheries Service estimates that in 1996, the aquaculture of clams and oysters was worth 20 and 64 million dollars respectively[3]. While leasing of submerged land has been used extensively for such practices, it can also be used for conservation.

In this report we explore the leasing of submerged lands as a potential conservation tool and examine some of the benefits, considerations and strategies for the leasing, preservation and restoration of these lands. A nationwide analysis of all coastal states' leasing legislation was done to acquire information regarding submerged land availability, procedures and costs for acquiring a lease, and criteria for maintaining a lease in each state. A variety of leasing options are explored, but we focus primarily on the leasing of areas for shellfish restoration because: (i) Most state leasing programs have specific provisions for shellfish development and harvest. (ii) Shellfish habitats are some of the few types of submerged lands readily available for lease that are amenable to restoration, conservation and management of native

1 *Temporary fishery closures are not considered in this accounting because they are likely to do little to protect diversity.*

2 *see http://oysterweb.dnr.state.la.us/oysterlease/default.htm*

3 *see http://www.st.nmfs.gov/st1/fus/fus97/commercial/ld-aquc.pdf*

species in natural environments. (iii) The restoration and conservation of shellfish ecosystems encourages stakeholders and local communities to take a strong interest in water quality and the link between estuaries and their watersheds. In addition, opportunities exist for leasing and restoration of other submerged ecosystems such as kelp forests in California or sponge and soft coral habitats in Florida.

The leasing of submerged lands and shellfish restoration can be combined in four main ways that offer different benefits and considerations as conservation strategies:

(1) Submerged lands can be leased and then simply protected from extractive activities.
(2) Submerged lands can be leased, restored with ecologically functional shellfish communities, then protected.
(3) Submerged lands can be leased, restored with shellfish, then sustainably harvested.
(4) Submerged lands can be leased, restored with shellfish, then unsustainably harvested.

Presently, most states' leasing policies require some production, and thus opportunities primarily exist for leasing with sustainable harvest (option 3). However, a few states do have provisions for leasing areas solely for the purpose of conservation, restoration, and/or protection (options 1 or 2). Obviously if conservation is a goal, then unsustainable harvest (option 4) should be avoided. As the leasing policies of various states come under review (often at the behest of industry), opportunities to include more options for conservation of leased submerged lands should be encouraged.

Even though restoration and protection (options 1 and 2) may be preferred, many conservation benefits can come out of limited and sustainable harvest (option 3). The benefits and considerations for these options are explored in depth. The strategies of leasing and shellfish restoration can be useful in and of themselves, but combined they offer some powerful synergies for the conservation and management of watersheds and coastal and marine ecosystems.

Table 1. Harvest-Limited Shellfish-Growing Waters of the U.S.: 1966-1995* (NOAA 1997)

	Thousands of Acres (percent total classified acreage)						
Publication Year	1966	1971	1974	1980	1985	1990	1995
Total Harvest Limited**	2,090 (21%)	3,733 (27%)	4,232 (29%)	3,533 (25%)	5,435 (32%)	6,398 (34%)	6,721 (31%)
Conditionally Approved	88 (1%)	410 (3%)	387 (3%)	587 (4%)	1,463 (9%)	1,571 (8%)	1,695 (8%)
Restricted	NA	30 (<1%)	34 (<1%)	55 (1%)	637 (4%)	463 (2%)	2,106 (10%)
Conditionally Restricted	NA	NA	NA	NA	NA	0 (-)	119 (1%)
Prohibited	2,002 (20%)	3,298 (23%)	3,811 (26%)	2,891 (20%)	3,335 (20%)	4,364 (23%)	2,801 (13%)

**Based on National Shellfish Registers (published only in years indicated). Data do not include Alaska, Hawaii or waters designated as unclassified.*

***Numbers in parentheses do not include waters designated as unclassified.*

< II >

Leasing of Submerged Lands

Different opportunities exist for leasing of submerged lands and shellfish restoration depending on the legislation for each state:

Legislation

All coastal states allow leasing in some portion of their waters. The allowance of such leases stems from the responsibility for the states to manage these public trust lands for the benefit of the people, and public trust concepts have been incorporated into state legislation to varying degrees. Coastal states recognize the importance of coastal areas to their economic and environmental well being, and leasing has been used historically as a tool to manage coastal activities and maximize economic and/or environmental benefits to the public (see, for example, Archer et al. 1994).

Leasing legislation was examined throughout the coastal states to identify potential opportunities for conservation. Information was gathered from managing agencies (usually state or county) regarding the process for attaining a lease, availability of land and specifics about leasing options and requirements (Appendix A). Where available, relevant legislation was also consulted; for instance, in many states distinct legislation exists regarding the leasing and use of submerged lands for aquaculture activities.

In general, the leasing process is straightforward: a potential lease area is identified, either by the interested party or by the State, and then surveyed to determine its appropriateness. (For example, an area might not be approved for leasing if it is an area where the State itself is likely to conduct restoration activities). During this stage, some states require that the application be available for public comment.

Once approved, a lease is granted for a standard period of time, such as one, five or 10 years, and is usually renewable upon expiration. Depending on lease terms, the lessee may receive exclusive harvesting rights of the submerged land, although generally receives no rights to restrict use of the water column or surface. However, this is changing in some areas as finfish aquaculture becomes more common. Because many states developed aquaculture leases to encourage commercial shellfish production, planting, production and/or harvesting quotas are often associated with the leases. The amount of required production and activity varies by state, and restrictions are often not strongly enforced.

In some states opportunities exist to lease areas without harvest or production requirements. In fact, some state agencies have offered alternatives for conservation-oriented leasing activities, such as leasing an area as a research sanctuary or reserve, and have thus eliminated planting or harvesting quotas in the interest of longer-term conservation. This may provide an opportunity for an area to be co-managed between the lessee and the State. Standards and requirements for these types of leases vary and are usually worked out ad hoc with the appropriate state agency. A brief and partial summary of leasing information for most coastal states is included in Appendix A.

Highlights of Potential Areas

Some states are more amenable to leasing submerged lands for a restoration project. Those states that offer the most promise have existing leasing procedures, available land, potential agency support and involvement, as well as potential community support and involvement.

The following are highlights of some states that have characteristics that might make a conservation leasing project feasible. Further analysis is likely to yield other possibilities at other sites and states. Some of the initial promising potential areas are listed below:

Maryland

Oyster production has a long history in the Chesapeake Bay, but over the past several decades this industry has suffered enormous declines (Rothschild et al. 1994). Several oyster reef restoration activities have been undertaken by the State, but their focus has been primarily to maintain commercial fishery activities, not long-term restoration. Maryland also has a submerged land leasing program for private oyster culture, which has not developed to any significant extent due to social and political constraints. However, public awareness is increasing regarding the importance of activities that will maximize long-term viability of natural resources, and a growing sense of support exists for restoration projects that focus on ecosystem health. The Maryland Department of Natural Resources Fishery Service may even be able to assist in management and help with monitoring of conservation oriented sites. Currently land is available to lease, and it is inexpensive ($300 initial fee and $3.50 per acre per year).

Mississippi

Mississippi also has a long history of harvesting and managing oysters. The State has an active shellfish lease program. In the interest of both working with outside organizations (e.g. The Nature Conservancy) and shellfish habitat restoration, the Mississippi Department of Marine Resources (DMR) has suggested some alternatives: (1) an area may be leased for shellfish enhancement activities and only opened to the public for harvest for a limited time, (2) an area may be kept closed to harvest altogether, and shellfish relayed to public areas or (3) shellfish areas that are currently harvest restricted because of poor water quality could be restored. The DMR has also expressed interest in offering assistance in the way of manpower and/or equipment to help establish or maintain appropriate conservation projects.

North Carolina

Since the beginning of the 20th century, several somewhat sporadic oyster restoration efforts have been undertaken in North Carolina. As with efforts in Maryland, the focus has been on maintaining oyster populations for harvest. Although North Carolina leases have production requirements, the Division of Marine Fisheries (DMF) has been redirecting its efforts toward creating optimum oyster habitat, and has become more focused on the best methods for designing long-term restoration projects. The DMF has developed research sanctuaries to experiment with different cultch materials and evaluate the ecological effects of biogenic three-dimensional oyster reefs. The DMF has shown interest in various options for working with other organizations to co-manage larger scale, longer time research reserves or shellfish management areas. There is land available, and costs for leasing would be negotiable. Several groups including The Nature Conservancy are working on oyster restoration projects. Military restricted areas also pose an interesting possibility for conservation projects, since they have limited access and are well staffed and funded for enforcement.

Connecticut

Connecticut has a long history of oyster production, as well as a history of leasing lands for oyster culture. The most productive shellfish areas have been set aside as public lands; the State seeds these areas annually and then transfers mature oysters to other areas to be fished. The State also regularly leases submerged land to private individuals to increase overall productivity. According to one contact in the Department of Agriculture's Aquaculture Division, the most promising features of leasing in Connecticut are: 1) the abundance of available land, 2) apparent "minimal" user group conflict, and 3) a sense of public and agency support. This sense of support and minimal conflict may be due to the fact that the most productive habitats are kept under public control.

Washington

Washington's Department of Natural Resources (DNR) is currently designing a new leasing program for submerged lands for conservation and restoration purposes. Historically, the DNR officially authorized very few restoration or enhancement projects for these lands; however, the current DNR administration has taken a different approach to restoration, enhancement and preservation activities. The DNR, through its Conservation Leasing Program, would now like to work cooperatively with project proponents to direct these types of activities throughout the state. To accomplish this, the DNR has developed three types of use authorizations: a Conservation Lease, a Conservation Easement and a Conservation License. In some cases it may be possible to use these submerged lands for scientific or research purposes, providing the State with research results (e.g., implementing a monitoring program) in lieu of standard lease fees. For the past few years the state has invested some effort into identifying areas as potential aquatic reserves; currently the DNR is establishing administrative rules concerning aquatic reserves.

Other Potential Areas

Other states not included in the above summaries have noteworthy characteristics as well; for example, in Oregon, The Division of State Lands expressed interest in assessing the least expensive way to lease land for conservation purposes; however, only a small amount of submerged lands are state-owned in Oregon.

Massachusetts has no statewide leasing process, so each county administers submerged land leases based on different criteria; in this state, it might be feasible to undertake a conservation project by working with the appropriate county agency.

Potential Considerations for New Legislation

While conservation organizations should focus on projects within the scope of existing state legislation, they should also look for opportunities to effect changes to make policies more amenable to conservation. Recently leasing policies have been changing in a number of states, often influenced by industry such as aquaculture (which is becoming more widespread and lucrative); however, many current policies are still inadequate to address the needs of local stakeholders in coastal areas (from fishermen to tourist interests and even wildlife). Consideration should be given to legislation that would allow more leasing for research, conservation and restoration purposes or require mitigation for other leasing that degrades public trust lands. Some of the information required to change legislation in many states will come from an increased understanding and better recognition of the economic and ecosystem services provided by functioning shellfish communities. Increasing this understanding is an important benefit of developing sanctuaries and restored protected areas (see Sections III and IV).

Tidelands at sunset in Port Susan, Washington. Washington State has recently been developing leasing policies that include allowances for conservation.

< III >

ECOLOGY AND ECOSYSTEM EFFECTS OF SHELLFISH

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Cobscook Bay, Maine is a relatively pristine estuarine system. It provides prime habitat for sea scallops, soft-shell clams and sea urchins, all of which are commercially harvested.

Bivalve shellfish are some of the most ecologically important and historically abundant species in coastal waters. They impact or control many ecological processes including, for example, primary production, nutrient cycling and water clarity and thus have been called ecosystem engineers (Cloern 1982, Officer et al. 1982, Newell 1988, Ray 1996, Lenihan and Peterson 1998). Because shellfish filter massive amounts of water, they can reduce the levels of bacteria, phytoplankton and other particulate matter in water bodies. Water clarity and dissolved oxygen, necessary for many marine organisms, may be increased by the great filtering capacity of shellfish; a mature oyster, for example, can filter up to 30 to 35 gallons of water per day.

By capturing suspended particles in the water column and releasing waste as a metabolic by-product, shellfish provide an important link between benthic and pelagic foodwebs (Newell 1988). Changes in estuarine water from losses of shellfish can lead to shifts from systems dominated by benthic primary production (seagrasses and benthic algae) to those dominated by planktonic primary production (algal blooms), and in some cases eutrophication (the reduction of dissolved oxygen levels resulting from increases in nutrients). In addition, these losses have resulted in system wide impacts such as changes in water flow and decreased water clarity (Jackson et al 2001b).

© MIKE BECK

Oyster skipjack in Chesapeake Bay. Today, these sailboats are the only types of boats allowed to trawl for oysters in the Bay.

While the loss of shellfish populations (and thus their filtering capacity) has contributed to declines in water quality, other factors such as increases in upstream nutrient runoff have also played a role. Because of these impacts, eutrophication threatens many estuarine and marine ecosystems. While some nutrient input is natural, too many nutrients can cause increased algal growth that blocks sunlight from reaching benthic plants that may provide food and/or habitat for associated marine species. Furthermore, as the algae die, bacterial decomposition uses up oxygen, resulting in anoxic conditions. The principal sources of excess nutrient input generally occur upstream in the watershed and include agricultural practices, urban runoff, septic systems, sewage discharges and eroding streambanks. As development increases on coasts and in watersheds, these inputs will likely increase and further threaten the health of many marine and estuarine systems. The combination of increased nutrients running out of coastal watersheds and decreased shellfish populations have had huge ecological impacts on many bays and estuaries. Restoring shellfish populations can mitigate some of these negative impacts.

© MAX STRIEB

Algae that cause brown tides are detrimental to scallops and eel grass. The presence of filter feeding shellfish in high abandance may limit brown tide-causing algae.

These types of ecological impacts (increased eutrophication, hypoxia, decreased water clarity, etc.) can also lead to cascading losses in other coastal habitats such as seagrasses that require clear water (Costanza et al. 1995). Some shellfish such as scallops require submerged aquatic vegetation for habitat. Decreases in scallops and other shellfish may have led to decreases in water clarity, which in turn have led to declines in eelgrass densities in a negative feedback loop. Conversely, the presence of an ecologically functional scallop community in an eelgrass bed may set up a positive feedback loop, contributing to the clear water necessary for seagrass survival and thus increased scallop survival.

Some shellfish also play a critical role in ecosystems by providing food, shelter and habitat for other estuarine and marine species (Posey et al. 1999). The role that biogenic three dimensional oyster reefs play in providing habitat for many species is only now starting to be fully appreciated. The presence of large healthy reefs can increase local fish and crustacean populations by providing additional refuge and spawning areas and by providing habitat for prey species (Coen and Luckenbach 2000). In fact, oyster reefs are now considered essential fish habitat for many species (see, for example, Coen et al. 1999).

Shellfish themselves also provide food for birds, large invertebrates and fishes. Degradation of reefs may cause the migration of crabs, fishes and other mobile consumers, and thus alter trophic interactions in nearby habitats as well (Lenihan et al. 2001).

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Oyster reefs provide habitat, food and shelter for numerous marine species.

Large oyster reefs also may protect nearby land from erosion by acting as natural breakwaters. A living ecologically functional oyster reef can provide a more aesthetically pleasing and ecologically sound solution to coastal erosion problems than groins, breakwaters, sea walls or jetties.

Finally, reefs with multiple age classes of oysters may be crucial for the survival of oyster populations themselves, as they provide concentrations of older individuals that are disease tolerant and have high fecundity (Burreson et al. 1999). Such reefs have been shown to export oyster larvae to surrounding environments (Southworth and Mann in press).

<IV>

Benefits of Leasing of Submerged Lands and Shellfish Restoration

A combination of leasing and shellfish restoration strategies could help to conserve and restore important habitats and ecological processes in coastal waters and watersheds and offers a number of additional benefits.

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Oyster tonging in Grand Bay National Wildlife Refuge, Mississippi. This type of oyster harvest has relatively little impact on oyster communities when done on an appropriate scale, and can be sustainable.

Leasing and shellfish restoration can be combined in four ways that offer different benefits as conservation strategies:

Option 1) Submerged lands can be leased and then simply protected from extractive activities.

Option 2) Submerged lands can be leased, restored with ecologically functioning shellfish communities, and then protected.

Option 3) Submerged lands can be leased, restored with shellfish communities, and then sustainably harvested.

Option 4) Submerged lands can be leased, restored with shellfish communities and then unsustainably harvested.

Even though out right protection (options 1 and 2) may be preferred, many conservation benefits can come out of restoration with limited and sustainable harvest (option 3), especially since this option may be the most feasible with current legislation (often requiring production). Obviously, if conservation is the goal unsustainable harvest (option 4) should be avoided (See Section V). Each of the above options offers several benefits (see Table 2 for summary):

Conserving and enhancing biodiversity.
Opportunities for leasing with protection only (option 1) are fairly uncommon but nonetheless do exist, and this option can be effective in the conservation and enhancement of biodiversity. Leasing for conservation can be effective in halting existing or preventing future degradation of biodiversity and may help to create protected areas in the marine environment. In places where outright ownership is possible (e.g., New York and Virginia), owning and protecting submerged lands may be a feasible option. In addition, policy in Washington State (currently being revised) may make leasing for basic conservation purposes a practical option. Again, these opportunities are rare.

© HAROLD E. MALDE

Foulweather Bluff, Washington. Emerging policies in Washington State may make leasing of submerged land for conservation purposes a feasible option.

Protection to enhance biodiversity may take several forms, even in states that have laws requiring production. For instance, in some states, the creation of spawner sanctuaries may be considered a significant source of production, and thus meet state-mandated production requirements (See Appendix A). In these areas, shellfish may be allowed to grow and become significant sources of seed. In other cases a good protection strategy may be to lease areas and protect them from extractive or incompatible activities (e.g., incompatible aquaculture).

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James Holland with blue crabs, Altamaha watershed, Georgia. Restoration of shellfish can lead to enhanced populations of ecologically and economically important species such as blue crabs.

Enhancing ecologically important species. Restoration activities on leased submerged lands (options 2 and 3) can enhance ecologically important species such as shellfish, crabs and fishes. Restored ecologically functioning shellfish communities can improve water quality as well as provide habitat for a number of organisms including crabs, fishes and birds, many of which are also economically important. Recreational and possibly even commercial fin and crab fishermen may support restoration projects due to their potential to enhance fish and invertebrate populations. Full restoration of ecological services and benefits will be most successful when shellfish communities are allowed to develop without harvesting (option 2). However, many of these ecological benefits can still be seen with sustainable harvest (option 3). In addition sustainable harvest has many socioeconomic benefits for local communities.

Partnering with local communities. Through leasing and restoration (options 2 and 3), conservation minded groups can work as stakeholders and partners within local communities to help conserve biodiversity and improve water quality. As a direct stakeholder in the marine environment and its resources, a conservation organization can get a "seat at the table" in the development of local and regional management policies that would affect these resources. Especially where sustainable harvest is allowed, conservation organizations can form unique and non-traditional alliances with local fishermen and other community groups.

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Planting oysters at York River, Chesapeake Bay. Projects such as this one, done in conjunction with a Rotary Club Conference, lend themselves to community involvement.

Partnering with fishermen to improve fisheries and water quality. Restoration projects that allow harvest (option 3) give conservation minded groups and individuals the opportunity to work with fishermen to improve fisheries and water quality instead of the all too common occurrence of creating antagonism between these two stakeholder groups.

Shellfishermen (a shorthand term for the extended family that is often involved in shellfishing) should be natural allies with conservation groups in the development of best management practices throughout watersheds, because water quality directly affects the number of areas open to shellfish harvest. Restoration with sustainable harvest gives both shellfishermen and conservationists common goals. Working together, fishermen and conservationists have a better chance at achieving community based conservation by reaching a wider audience and helping to educate other community members about the importance of clean water quality, increased habitat for fish and invertebrates and other conservation and management goals.

Providing opportunities for community outreach and education. Shellfish restoration projects on leased submerged lands are amenable to community outreach and educational activities (options 2 and 3). Examples of community based activities around shellfish restoration projects include: shell recycling programs, back yard oyster garden promotion, teacher training programs, volunteer habitat building and volunteer monitoring efforts. These types of activities actively involve the community in conservation efforts and thus benefit conservation projects.

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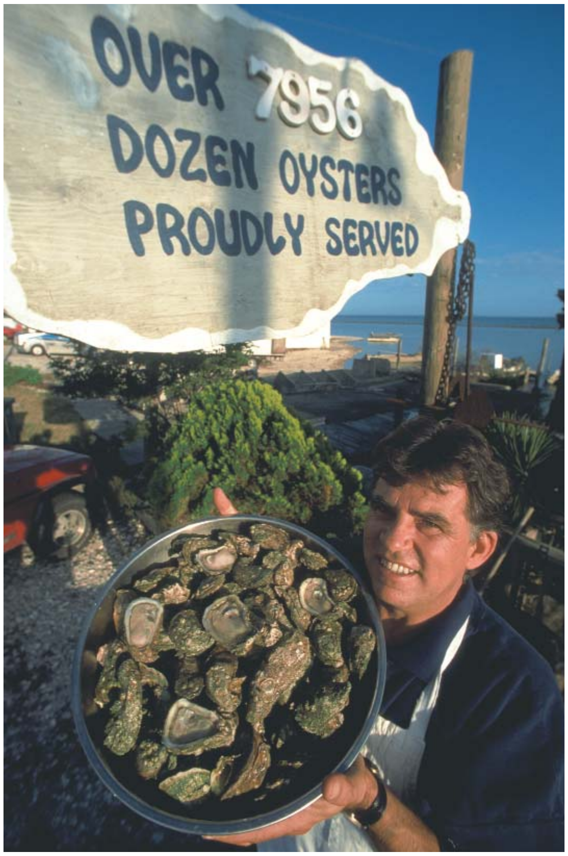
Community members build an oyster reef on Callawassie Island, South Carolina, as part of the SCORE! Program (see Appendix C). Restoration projects on leased submerged lands provide opportunities for education and outreach.

Developing ecologically and economically compatible management strategies. The promotion of sustainable harvests can be a goal in common between many fishermen and conservationists. Restoration with sustainable harvest (option 3) maximizes long term benefits for local stakeholders, both in fisheries resources as well as quality of life for the local community. Many conservation organizations do not need to maximize short-term economic benefits and can sustain losses while fisheries resources are fully restored. This delay in return on investment is a luxury not available to many shellfishermen working by themselves. The adoption of a longer-term vision may make it possible to sustain ecological and economic benefits.

Opportunities to increase the value of shellfish to local harvesters should be sought in order to help reduce overharvesting pressure. One of the best ways to reduce overharvesting and to build local community support is to identify opportunities to increase the value of shellfish. Unfortunately, shellfishermen often must overharvest the resource just to cover their short-term expenses of fishing. A consideration of strategies to increase the dockside value of shellfish would allow greater opportunities for cooperation in resource and watershed management.

Enhancing local economies. Local economies can be enhanced directly when sustainable harvest of shellfish or associated organisms is fostered (option 3) or indirectly through improved water quality and ecosystem services that a restored shellfish community provides (e.g. increased habitat for crabs and fishes) (option 2 or 3). In addition, other indirect economic benefits may arise. Since shellfish provide a number of ecosystem services such as biodiversity and water quality enhancement, estuaries with restored and protected shellfish communities may have clearer water, more submerged aquatic vegetation, more species of birds and fishes, and therefore be more amenable to ecotourism, recreational fishing, kayaking, birding, swimming and other recreational activities. These types of activities may enhance local economies.



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Apalachicola oysters for sale in Florida. Sustainable harvest on leased submerged lands can help support local economies.

Documenting ecosystem-level management approaches. The development of better strategies for conservation (option 1) restoration (option 2), and even harvest (option 3) will contribute to a wider understanding of the benefits of an ecosystem-level, long term view of management and conservation. This ecosystem approach is necessary whether the economic benefits are direct through harvest or indirect through other business enterprises (see above) or through the provision of ecological services (e.g., water clarification and nutrient cycling). The benefits of an ecosystem level approach for ecological conservation and economic development need to be documented so that they can be applied elsewhere; this documentation is vital to the future conservation and management of marine resources.

Using experiences from terrestrial leases. All four options offer opportunities to add market based mechanisms to the conservation and protection of marine biodiversity. In addition, the use of leasing and stewardship to conserve and protect resources has been well developed by many organizations in the terrestrial environment. Lessons from terrestrial experiences may translate well to the marine environment and may be welcome additions to traditional marine management practices, especially since submerged land leases are inexpensive.

Using cost-effective strategies. Not only are the leases themselves inexpensive, restoration projects on these lands can also be affordable (see Appendix A). Shellfish need no additions of food, nutrients, chemical fertilizers or daily human labor, and thus are essentially self sustaining; a restoration project will have little if any negative economic impact on a community. In fact, a restoration project likely, as stated above, will enhance the economy of a community.

Using areas as research zones. No matter what kind of conservation or management approach is taken, at least some areas will need to be left unharvested (options 1 and 2) to provide control areas to test whether or not the management approaches are successful. Leased lands can be utilized as research sanctuaries that can help address questions about the effectiveness of restoration and harvest approaches. Unfortunately, this type of assessment is uncommon. Many new "experiments" in marine management and conservation are not well replicated, monitored or controlled. In addition, if some areas are left unharvested, researchers may have the opportunity to learn more about and even quantify the importance of shellfish in many systems. For example, little is known about truly ecologically functioning shellfish reefs because there are few if any true reefs left. The return of some reefs to historical densities and heights is an important step toward understanding their ecology and contribution to ecological services.

Table 2: General Summary of Expected Benefits of Different Leasing and Restoration Strategies.

	Conservation and Management Strategy Associated with Leasing			
Benefit	Option 1: Protection Only	Option 2: Restoration + Protection	Option 3: Restoration + Sustainable Harvest	Option 4: Restoration + Unsustainable Harvest
Protect and enhance biodiversity	★★★	★★★	★★	NO
Enhance ecologically important species	★★	★★★	★★	★
Partner with stakeholders and local communities	★	★★	★★★	★
Provide opportunities for education and outreach	★★★	★★★	★★★	★
Partner with fishermen to improve fisheries and water quality	★	★★	★★★	★★
Develop ecologically and economically compatible management strategies	★	★★	★★★	NO
Enhance local economies	★★	★★	★★★	★
Document ecosystem-level management approaches	★★★	★★★	★★★	NO
Use experience from terrestrial leases	★★★	★★★	★★★	★★
Inexpensive	★★★	★★★	★★★	★★★
Use areas as research zones	★★★	★★★	★	NO

★★★ = substantial benefit ★★ = moderate benefit ★ = weak benefit NO = no benefit

<V>

Considerations for Leasing of Submerged Lands and Shellfish Restoration

As more intensive use is considered in leasing and restoration activities (from protection only to restoration with harvest) a number of issues should be considered to address real or potential shortcomings:

Effort may be better spent on conservation rather than restoration. For any restoration project (whether involving leasing or not) it is possible that funds might be better spent elsewhere on conservation or protection of the species or ecosystems of concern, especially if these species or ecosystems are found in healthy conditions elsewhere. In some of these cases it may not be appropriate to attempt restoration of degraded targets but instead be more appropriate to protect and conserve intact systems. The success of restoring fished species is still in question (Hutchings 2000) and there may be even more difficulty invoved with fully restoring functional ecosystems (for example, Minello and Webb 1997). However, in most cases, sufficient examples of unimpacted species and ecosystems are lacking; therefore, even if success is uncertain, attempts at restoration are necessary.

Need to avoid poorly designed projects. All aspects of a restoration project must be clearly thought out and designed. Restoration projects must only include native species of shellfish and should avoid introductions of non-native or genetically altered organisms. Non-native algae, shellfish competitors or disease organisms can piggyback in with non-native introduced shellfish. In addition, genetic changes such as hybridization can occur in shellfish communities, potentially diluting native genotypes. Introductions or genetic hybridization can impact the long term viability of a native shellfish community.

The designers of restoration projects should also consider other potential indirect effects from their projects. For example, predators may become locally more abundant around restoration projects, thus fostering a demand for increased predator control in nearby aquaculture operations. In addition, shellfish in a restoration project may compete with native zooplankton or other filter feeders in systems limited by primary production, but this has not been well documented. Finally conservation organizations who lease submerged lands should not only consider the size, placement and appropriate level of harvest of the proposed restoration project, but also how it might grow, change or be susceptible to harvesting pressure in the future.

© NOAA

The mud snail, Batillaria attramentaria, *is abundant on the Pacific Coast. It piggybacked in with the introduction of Japanese oysters.*

Need to avoid creating an intensive or destructive harvesting situation. A restoration project, in which long-term ecological effects are the goal, should not be confused with a farming project, in which shellfish beds are created primarily for subsequent harvest and sale. Indeed, any ecological benefits resulting from the creation or restoration of shellfish beds are reduced or lost upon harvest; unsustainable harvest (option 4) must be avoided. Furthermore any sustainable harvest that is allowed should not detract greatly from the conservation benefits of the project.

Need to avoid association with incompatible aquaculture. If leases are to be used for restoration and sustainable harvest, conservation groups must take care to avoid association with incompatible aquaculture that threatens the viability of marine ecosystems. Many practices in aquaculture are unsustainable at best and can be destructive at worst (e.g., Goldburg and Triplett 1997, Naylor 2000). Incompatible aquaculture may include practices such as using potentially more profitable but alien species, introducing genetically altered species, creating plots that are too large for the habitat to support, excessive dredging, raking or leveling, treatment with pesticides (carbaryl) or the use of "lethal" controls for predators. These types of practices can create an influx of invasive species (both directly as target species and indirectly in association with target species), degrade the genetic stock of native species, deplete wild stocks, alter or destroy natural habitats or poison or kill other organisms in the community.

Incompatible aquaculture projects also have the potential to change local nutrient or oxygen levels. Shellfish beds deposit large quantities of organic sediments on the surrounding benthos that promote increased nutrient cycling and sometimes anoxic conditions. The increased nutrients may encourage phytoplankton growth in some scenarios where nitrogen is limited in the water body (reviewed in Edelstein 2001). However, in places with high levels of anthropogenic nitrogen, shellfish are likely to consume more phytoplankton than they promote (Edelstein 2001). Changes in oxygen levels may also occur. High densities of cultivated shellfish may increase local oxygen demand, which may be exacerbated by the accumulation of decomposition of feces or pseudofeces in the surrounding benthos. Furthermore, these organic sediments may be more cohesive and prone to anoxic conditions than mineral sediments. Fences, pens, cages and predator exclusion nets may add to the deposition of organic sediments (Spencer et al. 1997). Choosing a site that is well flushed to build reef restoration projects may help prevent deposition of sediments and the associated problems.

Be aware of community sentiment toward restrictions on access to submerged lands. Many user groups perceive that marine waters should be fully accessible to the public. In some places, there are long histories of combativeness toward attempts to grant individual rights to marine resources. This negative response usually comes from recreational and commercial fishermen (e.g., McCay 1998). Conversely in some states and in other countries, these rights are widely accepted as being in the best interest of the fishermen and their resources.

Excessive interest in leasing of submerged lands could increase their costs. Given the low prices for many leases, even significant increases would not be overly burdensome. However, prices can increase astronomically based on the ability of buyers to pay. Recently some states have priced leases for the water column at substantially greater prices than those for the bottom[4]. This is related largely to the ability of salmon and other fish aquaculture interests to pay substantially more than other users for leases.

Enforcement may be necessary in order to prevent overharvesting. A restored shellfish habitat may be a target for poachers who might unsustainably harvest the shellfish and thus negate conservation benefits. Setting up restoration projects on land that is already closed to the public (e.g., in front of a prison or military base) may be one way of combating this issue, but this would then negate some of the benefits of community involvement. Funding for enforcement personnel may be a necessary component to the protection of successful restoration project.

4 See Massachusetts Office of Coastal Zone Management Aquaculture Strategic Plan Appendix C: http://www.state.ma.us/czm/spappb.htm

<VI>

Examples of Current Projects

The Nature Conservancy has several projects underway that illustrate the utility of leasing and/or shellfish restoration.

Virginia Coast Reserve, Virginia

The Virginia Coast Reserve (VCR) is a coastal wilderness that includes beaches, maritime vegetation, forests and salt marshes. Barrier islands, the thin strips of land that run parallel to the coastline along much of the Atlantic shore, comprise a large part of the coastal habitat. These 18 Virginia barrier islands serve as a buffer against storms, and are also at the convergence of different kinds of habitats that stir up a rich mix of life. This system of barrier islands, coastal bays and salt marshes has long supported natural resources which are invaluable assets to the Commonwealth and its citizens. However, a collapse in coastal fisheries resources in the 1930's immediately followed an almost instantaneous loss of seagrass, primarily eelgrass (*Zostera marina*.) In recent decades, both natural and manmade oyster reefs have also declined, and oysters are virtually commercially extinct in the coastal bays today. The Nature Conservancy owns submerged lands at the VCR.

© JOHN HALL

Looking for clams along Virginia's Eastern Shore.

Building upon earlier, successful efforts by the Virginia Institute of Marine Science (VIMS) and the Virginia Marine Resources Commission (VMRC) in South Bay to simultaneously restore oyster reefs and seagrass beds, The Nature Conservancy and VMRC received a NOAA Community Restoration Program Grant in 2002 to extend restoration efforts north to Cobb Island Bay. Reproductive shoots will be harvested from seagrass beds in the Chesapeake Bay by volunteers from the local community, and seeds will be planted by volunteers in Cobb Island Bay. Plans are to plant approximately ten acres of seagrass. In addition, 40,000 bushels of oyster shells will be planted adjacent to Cobb Island to create a reef that is approximately 25 feet wide, 45 feet long, and two feet high. Half of this reef will be on submerged lands owned by The Nature Conservancy and maintained as a shellfish sanctuary, and half will be on the public bay bottom. The long term goal of these efforts is to have both measurable impacts on water quality and biological diversity resulting from the water filtration and vital habitats provided by these organisms. Results to date suggest that the restoration of the oyster reefs is key to restoration of the seagrass, and that seagrass restoration is equally important to success in restoring the oyster reefs.

Cobscook Bay, Maine

A shallow 40-square-mile estuary with 200 miles of rugged, rocky convoluted shoreline, Cobscook Bay has avoided the heavy development experienced by most estuaries on the eastern seaboard. The bay plays a central role in the economies of the nine communities that lie along its shores. It provides prime habitat for sea scallops, sea urchins and soft-shelled clams, all of which are commercially harvested. In order to meet the challenge of balancing conservation of this highly diverse and productive system with the economic needs of the local people, The Conservancy is working with a variety of local partners. For example, work with fishermen and the local community demonstrates how mariculture can lead to successful and integrated conservation across environments.

The Conservancy helped start a sustainable communities project to reestablish the once-thriving clam resources in the bay. Mudflats were re-seeded with clams and research was conducted to understand how to reduce the impacts of introduced predators. The heightened community interest in the clams helped The Nature Conservancy to address a greater problem: discharge from faulty septic tanks. A community-based water quality monitoring system was established, septic tank problems were fixed, and thousands of acres of mudflats were reopened for public harvest. Most importantly, the success of the project led to the establishment of a new community organization, The Cobscook Bay Resource Center, which is helping the local community find ways to participate in management decisions at the state and local levels about the bay's wide array of marine resources.

Peconic Estuary, New York

The Peconic Region encompasses the watershed of the Peconic River, Long Island's longest river. Four interconnected bays link the Peconic Estuary to the Atlantic Ocean. The salt marshes, submerged eelgrass beds and mud/sand flats give food and shelter to the commercially important finfish and shellfish of the marine waters. The rare Kemps-Ridley sea turtle, harbor seals and countless shorebirds use the estuary for breeding or feeding grounds. Throughout the Peconic Estuary, the Conservancy works with the State, the five local towns, baymen and others to protect and restore critical marine habitats and high quality natural areas in the watershed. The Conservancy also worked jointly with the EPA in drafting the recently approved Comprehensive Conservation and Management Plan for the Peconic Bay, one of the 28 estuaries in the EPA's National Estuary Program.

In partnership with Southold Town Baymen's Association and the Town of Southold, the Conservancy has provided funds to create two permanent hard clam spawner sanctuaries, approximately one acre in size each. About 200 to 300 bushels of chowder and cherry stones (equaling 25,000 to 40,000 clams) were placed in each site. In addition, The Nature Conservancy staff has also worked with baymen and the Town of Shelter Island to designate three areas as clam spawner sanctuaries, and placed approximately 10,000 clams at each site. In both cases, the towns have passed resolutions designating these as permanent sanctuaries that will be closed to shellfishing. The Conservancy is currently working with the towns and brown tide researchers to designate two additional hard clam spawner sanctuaries in order to study the role of shellfish in controlling brown tide. Brown tide algae are detrimental to many marine species including eelgrass and scallops; however when shellfish densities are high enough they may limit the initiation of brown tides (see Section III).

To enhance the breeding stocks of scallops decimated by the brown tide, the Conservancy staff began another project to grow approximately 40,000 scallops at the Mashomack Preserve in Peconic Bay. Immature scallops 4-10 mm in size, provided by the Cornell Cooperative Extension, were placed in aquaculture cages at a volume of 750 ml per cage. After about six weeks, the scallops more than doubled in size (to a average size of 27.4 mm), and the volume had increased to an average of 3,166 ml per cage, more than four times the original volume. Two weeks later, approximately half of the scallops were released and about 8,000 were placed in the hard clam spawning sanctuary in Coecles Harbor, where they continue to grow. Throughout these stages, mortality remained less than two percent. It is predicted that these filter feeders will help control the development of brown tide. Experiments are in progress to test this prediction. By the summer of 2002, The Nature Conservancy expanded its operations to grow 100,000 scallops and 500,000 hard clams.

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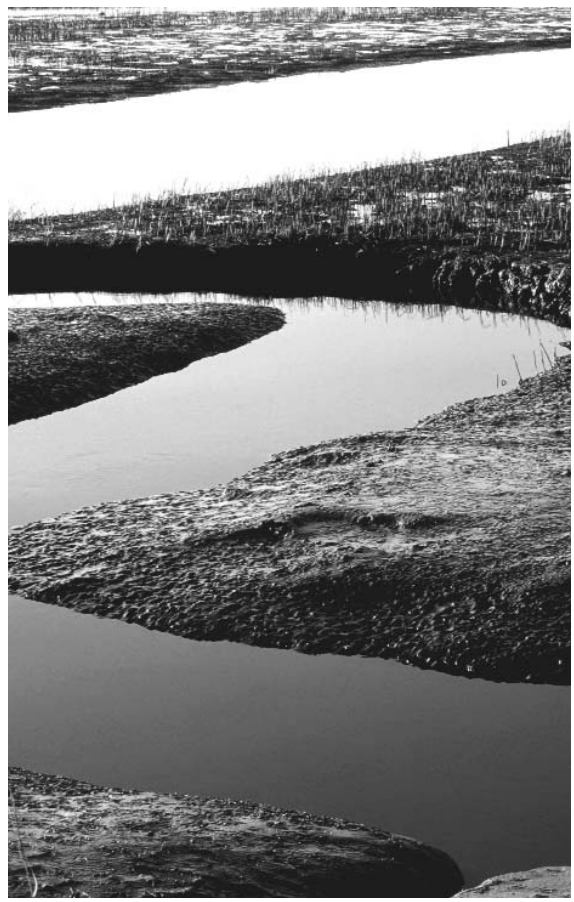
Tidal creek and estuary in Scallop Pond Preserve on New York's Peconic Bay.

PORT SUSAN, WASHINGTON

The Nature Conservancy of Washington has recently purchased 4,122 acres at the mouth of the Stillaguamish River on Port Susan Bay, protecting an extensive estuary, critical salmon habitat and one of the region's most important sites for thousands of migratory birds. This acquisition is the largest private purchase of land for conservation in Snohomish County's history. The property, located three miles south of Stanwood near Camano Island, has long been identified by biologists and ornithologists as one of the private parcels in the Puget Sound region most in need of conservation. The Conservancy has been working to protect the property for 11 years, but was just able to buy it from the former owner's estate.

The property contains 160 acres of diked uplands. The rest, nearly 4,000 acres, is a vast expanse of estuarine wetland, tidally influenced channels and mudflats, straddling the southern and northern mouths of the Stillaguamish River. The area lies within one of the most extensive estuaries in the Puget Sound region, creating an important transition area between marine and freshwater habitats. The river and estuaries provide critical habitat for coho, chum and the federally listed chinook salmon, as well as steelhead and sea-run cutthroat trout. This is also one of the most important sites in the Puget Sound region for herring and hake, both listed as state species of concern. Water quality problems have closed much of Port Susan's shellfishing grounds. The Nature Conservancy is now considering how to better manage the submerged lands on this property toward restoration projects that will further protect and restore these habitats.



© ALAN KEARNEY

Tidelands at sunset in Port Susan, Washington.

<VII>

Conclusion

With rapid development of watersheds and coastal systems, a broader tool kit for estuarine and marine conservation is needed. The leasing and restoration of submerged lands offers many exciting possibilities for better conservation. Conservation organizations have the opportunity to use existing legislation to lease submerged lands and restore ecologically functional shellfish communities on them. In many cases these leases will require some level of harvest, while in some cases areas may not need to be harvested and can be fully restored. Either way, restoration projects are relatively cost effective and can have enormous ecological benefits in coastal ecosystems. These benefits can include improvements in water quality, decreases in eutrophication, decreases in shoreline erosion and increases in habitat for a variety of fishes, invertebrates and birds.

Opportunities for sustainable harvest have additional benefits in that they directly enhance local economies and give conservation groups the ability to work with stakeholders (e.g., fishermen) and local communities in cooperation instead of competition.

Economic and ecological benefits of shellfish restoration projects can be appreciated by many stakeholders. These observations can promote community based conservation activities such as shell recycling programs, oyster gardening or volunteer and school monitoring programs. In addition, the allowance of sustainable harvest practices on leased submerged land encourages communities to be concerned about water quality, and this in turn will help direct conservation and management attention to the sources of reduced water quality in watersheds.

Increased interest in and understanding by communities of the ecological role that shellfish play in estuarine environments will help create more opportunities for coastal conservation. Leasing, restoration and protection provide an important link between watershed and estuarine conservation and should be added to our conservation tool kit.

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"A mountain of oysters. When spawning conditions are good, oysters in their natural state will attach themselves, one generation atop another, until great ridges of them exist up to high tide" F&W A-6151. South Carolina, 1938. Little is known about truly ecologically functioning shellfish reefs since few if any are left. Leasing and restoration projects may help us increase this understanding.

<VIII>

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Appendix A: Summary of Submerged Land Leasing Information by State (continued on next page)

	Alabama	California	Connecticut	Delaware	Florida	Georgia	Louisiana
Lead Agency	Department of Conservation, Marine Resources Division	Department of Fish and Game	Department of Agriculture, Aquaculture Division	Dept. of Natural Resources and Environmental Control, Division of Fisheries & Wildlife	Dept. of Agriculture and Consumer Services	Department of Natural Resources	Department of Wildlife and Fisheries
Contact	Mark Van Hoose (334) 861-2882	Fred Wendell (805) 772-1714	John Volk (203) 874-2855	Richard Cole (302) 739-4782	Mark Berrigan (850) 488-5471	Brooks Good (912) 262-3109	Ray Impastato (504) 568-5882
Initial Fee	*	$400	$200	$70	$200	*	$250
Annual Fee	*	$10/acre	$2/acre	$11.50/acre*	$25/acre	*	$2/acre
Planting Quota	*		No*	No	No	*	No
Production Quota	*	2000 oysters/ acre/year	No	No	No	*	Lenient*
Lease Period	*	25 year max.	3 – 10 years	Annual	10 year max	*	15 years
Min. Size	*	10 acres	10 acres	50 acres		*	
Max. Size	*	*	No	100 acres		*	
Comments	*No existing leasing process.	*Granted for commercial activity only. Kelp areas are also available for lease.	*Must have "some activity"; not specified how much.	Apply Jan 1- Mar 15 only; only certain areas available. *Resident fee only 90 cents/ acre/year	*Demand for land far exceeds desire to lease more land.	*State is not currently identifying new lease areas	*Must cultivate 10% of land area: annual signed affi-davit as proof.

Appendix A: Summary of Submerged Land Leasing Information by State (continued)

	Maine	Maryland	Massachusetts	Mississippi	New Hampshire	New Jersey	New York
	Department of Marine Resources	Department of Natural Resources, Fisheries Service	Department of Food and Agriculture	Secretary of State, Public Lands Division	Department of Fish and Game	Division of Fish & Wildlife, Bureau of Shellfisheries	Department of Environmental Conservation
Contact	Jon Lewis (207) 633-9500	Steve Minkinnen (410) 260-8326	Scott Soares (228) 374-5000	Corky Perret (617) 312-2153 ext. 5037	John Nelson (603) 868-1095	(609) 748-2040	Deborah Barnes (631) 444-0483
Initial Fee	$100 - $1000*	$300	*	$150	$200	$290	*
Annual Fee	$3.50/acre		*	$25	$200	$2/acre	*
Planting Quota		No*	*	*	No*	No	*
Production Quota	No**	*	*	No*	No*	*	
Lease Period	10 year max.	15–20 yrs.	*		Annual*		*
Min. Size	No	No	*				*
Max. Size	150 acres	No	*			2 acres*	*
Comments	*Cost depends on size: 1–10 acres is $250 initial fee. **Experimental lease may be offered for research.	* If area is "unused" for 3 yrs, could lose lease but this has never been enforced. State is encouraging oyster production in Chesapeake Bay.	*Leases granted at town level, conditions vary by town.	*Must be "active" on leased area. Usually areas must be open, but may be able to keep an area closed for conservation purposes. May be more opportunities to lease submerged lands if applicant owns the upland.	*No lease program exists, only scientific or aquaculture permits. Does not anticipate an easy time getting public support.	*Each lease cannot exceed 2 acres, but may hold more than one lease (must be approved one at a time).	*No leasing program for State-owned land; may apply to townships to lease town-owned land.

Appendix A: Summary of Submerged Land Leasing Information by State

	North Carolina	Oregon	Rhode Island	South Carolina	Texas	Virginia	Washington
Lead Agency	Division of Marine Fisheries	State Lands Board, Division of State Lands	Coastal Resources Management Council	Marine Resources Division	General Lands Office	Marine Resources Commission	Department of Natural Resources
Contact	Craig Hardy (252) 726-7021	Larry Potter (503) 378-3805	Dave Alves (401) 783-3370	Skipper Keith (843) 762-5029	Lance Robinson (512) 389-4800	Tony Watkinson (757) 247-2255	Jay Udelhoven (360) 902-1060
Initial Fee	$100	$25*	*$100-$200		*	$25 + survey	$25
Annual Fee	$5/acre	$2*	*$150 first acre/$100 per		*	$1.50	30% upland value*
Planting Quota	50 Bushels or 25 bushels seed/year or combination	No	**	50 bushels seed or cultch/year*	Negotiable	No	No
Production Quota	10 bushels/ acre/year*	No	**		Negotiable	No*	No
Lease Period	10 years	Indefinite	5 year max.	5 year max.	1-20 years*	10 years	12-30 years
Min. Size	0.5 acres		No	**	*		
Max. Size	50 acre max. total per entity.		No		*		
Comments	*Standard lease must be commercially harvested; better option would be reserve or research sanctuary.	*Fees are negotiable, but there isn't much state-owned land.	*Fees vary with size of lease. **Lease must be actively "farmed." May be able to make adjustments for conservation purposes.	*Must be a commercial enterprise. **Not much land available for lease.	* Current moratorium on leases.	*Must show "good faith effort" for propagation to renew lease.	*May be negotiable: if area were used primarily for conservation purposes they may accept monitoring/researh activities in lieu of fees.

Appendix B: General Principles of Shellfish Restoration

Because of the ecological importance of shellfish populations, many shellfish restoration projects have been undertaken throughout the United States, especially along the Gulf of Mexico coast. Historically, the primary goal of these projects has been to enhance commercially exploited populations. Only more recently have some efforts focused more on the importance of maintaining the ecological role that shellfish fill, with projects aimed at enhancing ecosystem function. Projects have varied in scale as well as methodology. In this section we offer some basic ecological considerations for one type of shellfish restoration (oyster restoration), and describe some projects that various states have undertaken, including methodology, project costs and to the extent known, degrees of success.

Ecological and Methodological Considerations for Oyster Restoration

Many shellfish restoration efforts have focused on oysters. Some of the considerations when restoring or constructing a reef include the suitability of the location, the amount and types of material to be used, and the size and morphology of each reef (e.g., the amount of vertical relief and interstitial space that the reef will provide).

Oyster larvae are free swimming for the first few weeks of their lives. When they find suitable substrate (cultch), they attach to it and begin to grow. The newly set oysters are called spat. Larger oyster populations lead to increased larval settlement. To support the oysters, the substrate must be hard, relatively unfouled, and stable enough to resist subsidence.

Oyster reef restoration involves either creating new reef areas or restoring existing ones to accommodate oyster settling. Both methods often involve adding substrate material to the restoration area. The most commonly utilized technique for providing suitable substrate is planting cultch, the material the juvenile oysters (spat) attach to. This has proven to be both successful and cost effective. Planting is usually undertaken during a spawning season and when water temperatures are not too high to allow survival of spat and young oysters. Some organizations have encouraged community based shell recycling programs to provide this cultch.

Choosing a Site

One of the most important things to consider with any type of enhancement project is where to do it. For shellfish restoration, the most critical criterion in choosing a site is having sufficient recruitment capability (appropriate site placement for larval settlement and development). In general, sites are usually located on or near reefs that have a history of good production; however, likelihood of success will be increased with increased knowledge of the area in question (for example, water quality, salinity, current velocities, temperature and density stratification, sedimentation rates, oxygen levels, abundance of predators, and risk of disease). Shellfish can survive and flourish in a range of salinities and temperatures; however, settling and subsequent growth and survival can be disrupted by inappropriate levels or sudden changes in any of these factors (see, for example, Abbe 1986, Lenihan et al. 1996, Lenihan and Peterson 1998, Lenihan 1999). Ideally, a chosen site is one where recruitment monitoring has occurred for one or more years prior to restoration and significant recruitment has been found, since variability of recruitment can be very high.

Materials

A large variety of materials can be used as substrate. Research indicates that oyster larvae settle in response to water borne pheromones, mantle fluid, metabolites and shell leachates from living oysters and/or their remains; therefore, the most successful materials for larvae settlement are usually molluscan shell.

Where available and cost-effective, processed oyster shell has been the cultch material of choice for most practitioners. Dredged oyster shell from ancient reefs has also been used, but the environmental concerns associated with dredging along with the smaller pieces of shell it provides make this less than ideal. (In Texas, however, the State worked with the Army Corps of Engineers to procure shell that was dredged during major construction projects to construct oyster reefs as mitigation). In addition, oyster shells may hold up better than other shells (e.g. surfclam); and the bigger pieces will provide more interstitial space for initial colonization and survival of oysters. Some communities have initiated shell recycling programs with local restaurations to provide this shell material.

Limestone has also been effective on established, relatively hard reefs. Because of its density, it is not favored as cultch on relatively soft bottoms, where it has a greater tendency to subside. In addition, limestone can be expensive. Other materials including aggregates of crushed concrete-coal fly ash have also been used with some degree of effectiveness. Ultimately, the material chosen will depend upon environmental considerations, availability and cost. Optimal substrates support the weight of the oysters and usually contain at least 10 percent (by volume) of shell or other material (e.g., rocks) and a mixture of sand, silt and clay particles.

Depositing Cultch

There are two basic ways to get cultch onto a reef site. It can either all be taken to the site and deposited as a reef structure, or some kind of pre-made substrate can be deposited first and then covered with cultch. If a project occurs on an area where there is existing reef material (e.g., a historic shellfish bed), a thin layer of new cultch can be applied to the top. New cultch is usually deposited in densities of approximately 100–150 yd^3/acre and spread in a thin layer over the reefs.

Alternatively, cultch can be towed out to the site on a barge and washed overboard using high-pressure "water cannons" as the barge is maneuvered slowly over the reef. This is a common method and provides for dispersion of shells in a thin layer over reefs. Draglines with clam buckets are used as well, especially in smaller, shallower areas where deck barges cannot float or be maneuvered safely and effectively. However, a large amount of cultch is required to produce the necessary elevation and to stabilize the area. Cultch should be planted at depths of 15-25 cm (recommended by Brodtmann 1991, Meyer 1997, Coen et al. 1999).

The morphology of the reef is also important. High profile reef structures are generally much more productive than low-lying oysters (on scattered remains or reefs) or oysters on the bottom (tidal flats) (one study found 11 spat per meter on the bottom compared with 100 spat per meter on the reef). As noted earlier in the report, large reefs that rise well off the bottom have increased surface area and interstitial spaces; these features make them highly productive and conducive to enhanced biodiversity.

Harvest

Historically, most shellfish restoration or enhancement projects have been undertaken to sustain or improve fishery harvests. Restoration sites can add to harvestable areas either indirectly (e.g. when closed areas are opened to harvest because of improved water quality) or directly (if the restoration site itself is harvested). This can be an important benefit of a restoration effort, but must not come at the expense of the loss of the ecological benefits discussed earlier. In the case of a leased area, the lessor usually maintains exclusive harvesting rights, and can determine to what extent the area may be fished. Any harvest of a restored reef should maintain the three-dimensional nature of the structure and/or a core reserve area. Harvest could also be planned around closed areas or closed seasons, or preferably, the restoration area might be set aside as a reserve, and adult organisms could be transferred to other, open fishing grounds.

Management

Any successful long-term project must have a strong management plan. In some cases a management plan is one criterion for obtaining or renewing a lease. For a restoration project, the management program should focus on ecological changes in the area and should include baseline data, recruitment, growth and community changes. Management should also promote the growth of older oysters, which can bring increased fecundity as well as the development of disease resistant strains of oysters (Coen and Luckenbach 2000). Prevention of unsustainable harvest methods is another important aspect of management. Enforcement and patrol of restoration sites may be necessary to prevent oyster or other shellfish pirating. Ideally, activities on leased land, including any management measures, should be laid out prior to the initiation of activities, making it easier to work with the agencies and communities to define the scope and expected outcome of the restoration project. Support and/or involvement from the community should also be measured periodically.

Cost

The exact cost of any project will vary given the extent of the project, materials used, extent of support from or collaboration with other organizations or agencies and other costs (for example, enforcement, other management costs). The following provides some cost estimate for planning a shellfish restoration project.

- Oyster restoration projects in Louisiana following Hurricane Andrew (described below) utilized a total of 42,576 cubic yards of cultch were planted over 306 acres. The cost of purchasing and planting cultch was $21/yd^3$.

- Reef construction projects in Virginia's Piankatank River (described below) utilized approximately 207,000 bushels of oyster and clam shells to construct a reef 300 m long by 30 m wide by 1.8-2.0 m deep, which consisted of 22 individual intertidal mounds. The total cost for the project was $137,908, or $460 per linear meter of reef structure (Wesson et al. 1999).

- In a second project in Virginia, reef structures were built using existing bottom substrate in an area with firm bottom and high buried shell content. In this case, approximately 7,575 linear meters of reef structure were built, and afterward 80,000 bushels of clam shell cultch were spread over the area (about 50 acres). The final cost for the project was $251,887 total, or $39/linear meter, much less expensive than the former project.

- Between 1989 and 1994, Alabama undertook some oyster restoration projects. Oyster shell was donated from the oyster industry, and the Alabama Department of Conservation transported and planted them. Costs varied from $14.20/m^3 – $31.30/m^3, with an average of $20.78/m^3.

Based on the above values, the costs of projects like these may range from $15-$35 per cubic yard for materials and labor. As a note of interest, the Louisiana Department of Wildlife and Fisheries did cost-benefit analyses of oyster restoration projects for five separate years (where cost = cost of planting shell, benefit = total value of harvested oysters), and calculated that the cost to benefit ratios ranged from 1:2.5 to 1:7.4.

Examples of Oyster Restoration Projects

Louisiana

The passage of Hurricane Andrew through coastal Louisiana in 1992 devastated local oyster populations. Prior to Hurricane Andrew, oyster densities in Caillou Lake ranged from 19 to 67.5 oysters/m^2 (for oysters that were one to three inches in size) and 6 to 76 oysters/m^2 (for oysters greater than 3 inches). One week after the hurricane, densities ranged from 10 to 16 oysters/m^2 (one to three inch oysters) and 5 to 14 oysters/m^2 (oysters greater than 3 inches) (Perret et al. 1999). In response, the Louisiana

Department of Wildlife and Fisheries developed the Louisiana Shellfish Restoration and Enhancement Project. The two primary objectives of the project were to clean reefs buried by sediment and to replace lost cultch. In Caillou Lake and Bay Junop, a total of 1,430 acres were cleaned. Dredging was used to removed silt and shift the shell to expose clean surface area. In addition, 42,576 cubic yards of cultch were planted over 306 acres in the lake (the bay was not planted because it was too shallow). The cultch, which consisted of reef shell substrate from Atchafalaya Bay, was washed overboard from barges with high pressure water hoses in three phases over a four week period. Eight months after planting, densities on the cleaned sites had returned to pre-storm levels, and densities on planted sites ranged from 5 to 81 0-2 inch oysters/m^2.

North Carolina

Since the beginning of the last century, North Carolina has undertaken several projects aimed at enhancing the productivity of the oyster fishery. From 1915 to 1920, between 10,000 and 20,000 bushels of shells were planted annually; results were promising, and by 1923-1924 annual planting had increased to approximately 700,000 bushels. Planting declined through the 30's and early 40's, as did oyster landings. Although planting increased again through the 50's, landings did not increase proportionally, possibly due to hurricane activity or insufficient planting (North Carolina planted a total of 1,188,822 bushels of shells and seeds over 10 year; Virginia and Maryland were planting an equivalent amount in a period of one year and six months respectively). Cultch planting continues today, but the methods have changed very little, and the fishery has not regained historic productivity. More recently, focus has shifted from the provision of harvestable oysters to include habitat creation and enhancement; such projects are monitored and evaluated for the best ways to provide long-term oyster habitat.

Virginia

In 1993, the Virginia Marine Resources Commission's (VMRC) Oyster Replenishment Program undertook some projects with the goals of investigating different methods of constructing reefs and of understanding the ecological value of reef structures. One such project, undertaken jointly by VMRC and Virginia Institute of Marine Science (VIMS), was construction of the Palace Bar Reef in the Piankatank River. An intertidal reef 30 meters by 300 meters by about 1.9 meters high was constructed by deploying approximately 207,000 bushels of oyster and clam shells on the footprint of a historic oyster reef. Since then, physical conditions and oyster population development have been regularly monitored, and the community structure has been compared with community structures on nearby non-reef habitats. The reef is now home to a multi-level biological community. Three other reefs were also constructed in the Piankatank River in 1995, and are showing signs of equally healthy development.

Other efforts by the VMRC and VIMS in the coastal bays to simultaneously restore oyster reefs and seagrass beds began in 1997 and have shown almost immediate success. Oyster populations have increased on constructed reefs, and seagrass from both transplants and seeds have survived since 1997 on numerous sites. Results to date suggest that restoration of the oyster reefs is the key to restoration of seagrass, and that seagrass restoration is equally important to success in restoring the oyster reefs.

South Carolina

In South Carolina, the Department of Natural Resources' Marine Resources Division (MRD) has undertaken a community-based oyster restoration and enhancement program. The MRD works in collaboration with state and local partners and volunteers, including local citizens, schools and community organizations. The MRD works with partners and other volunteers through all stages of a restoration project, from selecting a site and deploying cultch to subsequent monitoring and assessment. Prior to deploying natural cultch, sites are chosen based on their suitability (environmental conditions and location). In some cases where site suitability may be unclear, hatchery-reared spat are placed on potential sites and their growth and survival are monitored. At chosen sites, cultch is loaded onto boats and deposited with buckets over the area.

Several shell trays are also deployed at each site. These trays contain oyster shell like the shells that are planted on the new reef site, but are placed adjacent to the new reef. These can then be sampled without disturbing the reef and monitored to determine if recruitment is occurring. Bags of hatchery-reared spat are also deployed at each site, and their growth and survival are monitored. Thus the relative quality of the newly created habitat can be determined. Environmental conditions are also monitored (for example, salinity, temperature, pH, turbidity and chlorophyll), as well as erosion and shell displacement at the reefs. In association with this type of project, the MRD also established an oyster shell recycling program to encourage people to recycle clean oyster shells that can be used for further restoration projects.

Appendix C: List of Relevant Web Sites

State Statutes and State Leasing Program Information

- Florida Division of Aquaculture: http://www.floridaaquaculture.com/
- Louisiana Oyster Legislation and Lease Survey Section Information: http://oysterweb.dnr.state.la.us/oyster/
- State Submerged Land Leasing Survey: Massachusetts Office of Coastal Zone Management Aquaculture Strategic Plan http://www.state.ma.us/czm/spappb.htm
- Maine Department of Marine Resources: Forms and Applications: http://www.dnr.statems.us/tidelands/tidelands/htm
- Mississippi Tidelands Funds http://www.dnr.state.ms.us/tidelands/tidelands.htm
- Oregon Department of Agriculture Natural Resources Division's Shellfish Program: http://www.oda.state.or.us/Natural_Resources/oyster.htm
- State Land Leasing Information: http://www.iogcc.state.ok.us/STATELANDLEASINGINFO.htm
- Washington: Aquatic Land Management: WA State Legislature: http://www.leg.wa.gov/wac/index.cfm?fuseaction=chapterdigest&chapter=332-30

Other Web Sites of Interest

- Aquatic Reef Restoration in the Chesapeake Bay: http://www.chesapeakebay.net/reefrest.htm
- Cleansing waters: The Shellfish Solution: http://www.marinehabitat.org/cleansing.html
- EPA's Clean Water State Revolving Fund Information: http://www.epa.gov/owmitnet/pdfs/sfish.pdf
- EPA's Environmental Indicators of Water Quality in the United States: http://www.epa.gov/iwi/help/indic/tblcont.html
- EPA Marine and Coastal Geographic Information: http://www.epa.gov/owow/oceans/maps/
- EPA's Shellfish Web site: http://www.epa.gov/OST/shellfish/index.html
- Interstate Shellfish Commission: http://www.issc.org/
- Massachusetts Shellfish Bed Restoration Program: http://www.epa.gov/OWOW/estuaries/coastlines/winter97/shellfi.html
- NOAA 1995 National Shellfish Register of Classified Growing Waters: http://www.orca.nos.noaa.gov/projects/95register/index.html
- Oyster Gardening Education Program in Maryland: http://www.mdsg.umd.edu/oysters/garden/
- Oyster Sanctuaries: an ecological approach to restoration: http://www.mdsg.umd.edu/MarineNotes/Jul-Aug99/index.html
- SCORE! South Carolina Oyster Restoration and Enhancement Web site http://www.csc.noaa.gov/scoysters/html/bio.htm
- South Carolina's DNR Shelfish Research: http://water.dnr.state.sc.us/marine/mrri/shellfish/index.htm
- VIMS Oyster Reef Restoration Projects: http://www.vims.edu/mollusc/monrestoration/memonrest.htm

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